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(54) Title: NONWOVEN AND FILM CORRUGATED LAMINATES

(57) Abstract

The present invention is directed to corrugated laminates with density differentials created in at least one of the layers of the laminate. The laminates (10) include a first layer (12) bonded to a second layer (14) to form a composite which has a plurality of corrugations forming a series of peaks separated by a series of valleys. At least the second layer is formed from a compressible material such as a fibrous nonwoven web which has formed therein areas of different density due to the formation process used to form the laminate. In one process the first and second layers are bonded to one another along a series of generally parallel bond lines (16) while at least one of the materials is in a tensioned state. Once bonding is completed, the tension is released and the laminate forms a series of corrugations. In the valley areas (18) immediately adjacent the bond lines the laminate and in particular the second layer has an increased density due to the bonding process. In the peak areas (20), which are between the valley areas, the laminate and in particuar the second layer has a lower density. As a result, fluids entering the laminate through the first layer tend to be drawn toward the more dense areas adjacent the bond lines. This couples with the reduced surface contact area of the first layer due to the corrugations, tend to make the material particularly well-suited for use as a body side liner for personal care absorbent articles.

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NONWOVEN AND FILM CORRUGATED LAMINATES

FIELD OF THE INVENTION

The present invention is directed to corrugated laminates of two or more layers which can use among other materials films and nonwovens to form the laminates. The laminates have a wide variety of applications, including, but not limited to cover materials for personal care absorbent articles.

BACKGROUND OF THE INVENTION

Laminates are composite materials made from two or more layers or sheets of material which have been attached to one another. The resultant laminates can be used for a number of applications including for example, cover materials for personal care absorbent articles such as diapers, training pants, feminine hygiene products such as sanitary napkins, incontinence devices, bandages and the like. All of these products typically include a body side liner or cover, an outer cover or backing sheet and an absorbent core disposed between the body side liner and the outer cover.

Two of the most commonly used materials in constructing the body side liners and outer covers of such articles are plastic films and fibrous nonwoven webs. Plastic films have the advantage that they are liquid impervious. As a result, they are commonly used as the outer cover material for such articles. If perforated or otherwise apertured, they can pass liquids thereby making them useable as body side liners for

the same articles. Nonwovens generally by design are both liquid and gas permeable. As a result, when used as body side liners, they will readily pass body fluids such as urine and menses. If the pore structure of such nonwovens is made, for example, sufficiently small, the same nonwovens also tend to become resistant to liquid penetration and therefore can be used as outer cover materials as well. Lastly, it is also possible to combine such films and nonwovens in various configurations to form laminates which can be used for the same purposes.

When using films and nonwovens either alone or in combination for body side liners for personal care absorbent articles, several disadvantages become apparent, especially when such materials are used in conjunction with body fluids such as menses. Menses when compared to other body fluids such as urine is highly viscose in nature due its blood-based composition and high particulate content. As a result, it is oftentimes difficult to completely transfer such materials all the way through the body side liner and into the absorbent core for storage until the article is discarded.

From a personal hygiene standpoint, it is desired by the user that there be as much separation of such body fluids as urine and menses away from the skin of the user as is possible to provide a cleaner and drier feel. In addition it is desirable for the body side liner to have as little contact with the user as is possible. Unfortunately, such materials do not provide sufficient three-dimensionality to always provide the user with such a clean and dry feel. As a result, it is an object of the present invention to provide a material which can be used in such applications and provide such a perception. The same materials also may be used for a wide variety of other applications as will become more apparent from the following description, drawings and claims.

SUMMARY OF THE INVENTION

The present invention is directed to corrugated laminates of two or more layers of material. The laminates comprise a first sheet of material attached to a second sheet of material at one or more locations between the sheets which result in a plurality of generally parallel corrugations forming a series of peaks separated by a series of valleys. The laminate in the vicinity of the peaks has a first density and in the vicinity of the valleys has a second density with the second density being greater than the first density.

The materials from which the first and second sheets may be formed vary widely and include, but are not limited to, films, wovens, nonwovens, foams and laminates of one or more of the foregoing materials. In order to obtain the density differential between the peaks and valleys of the laminate it is desirable that at least one of the materials be made from a compressible web which is capable of having its density changed. A fibrous nonwoven web is but one example of such a material.

In addition to having a density differential, it is also possible to have a pore size differential in the laminate according to the present invention. For example, if either or both of the first and second sheets are made from a compressible web such as a fibrous nonwoven web, then the laminate in the vicinity of the peaks may have a first average pore size and in the vicinity of the valleys may have a second average pore size with the first average pore size being greater than the second average pore size.

The size and spacing of the peaks and valley will vary

depending upon the particular end use. Generally, however, the laminates will have spacing between adjacent peaks of from about 2 to about 7 millimeters and the vertical height of the laminate will range between about 0.5 and about 5 millimeters especially when such materials are being used in conjunction with personal care absorbent articles.

Personal care absorbent articles include such products as diapers, feminine hygiene products including sanitary napkins and pantiliners, incontinence devices, training pants, bandages, wipes and the like. Typically these articles will have a design which will include a body side liner and an outer cover with an absorbent core disposed therebetween. Such articles will also typically have a longitudinal and a transverse axis with the longitudinal axis corresponding to the longer dimension of the product.

The laminate of the present invention is particular well-suited for use as body side liner in such personal care absorbent articles. The corrugations act to distance the product from the user and to trap solid particulate matter in the valleys of the corrugations thereby providing enhanced comfort to the user. As shown by the drawings, the corrugations can be positioned to be generally parallel to either or both the transverse and longitudinal axes of the product. In more specific embodiments, the body side liner can be designed to have two side regions separated by a central region with the corrugations in the central region being generally perpendicular to the corrugations in the two side regions.

Several processes are described herein for forming materials according to the present invention. In one process the first and second layers of material are placed in generally face to face relationship and then at least one of

the first or second layers is stretched. While in a stretched state, the two layers are bonded together at spaced apart generally parallel bond lines to form the laminate. Once the bonding has taken place, the laminate is allowed to relax thereby forming a plurality of corrugations which include an alternating series of peaks and valleys with the laminate in the vicinity of the peaks having a first density and in the vicinity of the valleys having a second density with the second density being greater than the first density. Depending on the equipment being used, the process can be varied as, for example, by deleting the stretching step and/or applying and adhesive between the first and second layers to further aid in the bonding.

One apparatus used to form laminates according to the present invention includes a first geared tooth roll having a plurality of teeth about its periphery with these teeth defining a first angle therebetween. This first geared tooth roll is designed to intermesh with a second geared tooth roll which also has a plurality of teeth about its periphery which define a second angle therebetween. The angles are designed such that the first angle of the teeth on the first roll are greater than the second angle of the teeth on the second roll. As a result, the apparatus is able to form the corrugated laminates according to the present invention with varying densities between the peaks and the valleys.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a cross-sectional side view of a nonwoven and film corrugated laminate according to the present invention.

Figure 2 is a partial cut-away perspective view of a personal care absorbent article, in this case a sanitary napkin, which utilizes a nonwoven and film corrugated laminate

according to the present invention as the body side liner of the personal care absorbent article.

Figure 3 is a cross-sectional side view of the personal care absorbent article of Figure 2 taken along line 3-3 of Figure 2.

Figure 4 is a schematic side view of a process for forming a nonwoven and film corrugated laminate according to the present invention.

Figure 5 is a schematic side view of another process for forming a nonwoven and film corrugated laminate according to the present invention.

Figure 6 is a partial side view of a pair of geared corrugating rolls which can be used in conjunction with the process shown in Figure 5.

Figure 7 is a top plan view of a body side liner of a personal care absorbent product utilizing a laminate according to the present invention.

Figure 8 is a top plan view of a body side liner of a personal care absorbent product utilizing a laminate according to the present invention.

Figure 9 is a top plan view of a body side liner of a personal care absorbent product utilizing a laminate according to the present invention.

Figure 10 is a top plan view of a body side liner of a personal care absorbent product utilizing a laminate according to the present invention.

Figure 11 is a photomicrograph of the material according to the present invention as described in Example 1.

Figure 12 is a photomicrograph of the material according to the present invention as described in Example 2.

DETAILED DESCRIPTION OF THE INVENTION

Referring to Figure 1 of the drawings, there is shown a laminate 10 according to the present invention, including a first layer 12 and a second layer 14. While this is the most basic embodiment of the present invention, it should be appreciated that more complex embodiments can be made by adding additional layers (not shown) to the laminate 10 and these additional embodiments are also contemplated to fall within the scope of the present invention.

Both the first layer 12 and the second layer 14 can be made from a wide variety of materials including but not limited to films and fibrous nonwoven webs as well as combinations of the two materials. As shown in Figure 1, the first layer 12 is a layer of film with a plurality of apertures 13 defined therein and the second layer 14 is shown as a layer of fibrous nonwoven web material. Other materials can be used for either or both the first layer 12 and the second layer 14. Examples of other materials include, but are not limited to, foams, tissues, coform materials and combinations of the forgoing materials. When using the material of the present invention as, for example, a body side liner for a personal care absorbent article such as a sanitary napkin, it is desirable that at least one of the layers be a compressible web. By that it is meant a web which, when subjected to compression and/or bonding techniques, will have an increase in its density and a reduction in the average pore size of the structure in specified areas of the structure.

Foams and fibrous structures such as wovens and nonwovens are particularly good examples of compressible webs. Examples of suitable nonwoven webs include, for example, air laid and wet laid webs as well as bonded carded webs all of which are typically made from staple length or shorter fibers. The fibers themselves may be natural or synthetic as well as a blend of fibers as is possible, for example, in coform materials. Synthetic fibers which are made from or include materials which are thermobondable have been found to work particularly well as they can be heat bonded to one another as well as to other fibers which is helpful when changing the density of the second layer as is required by the present invention. To this end, multiconstituent and multicomponent fibers such as biconstituent and bicomponent fibers have been found to work particularly well. Nonwoven webs made from more continuous fibers such as spunbond fibers and meltblown fibers can also be used to form one or both of the layers of the present invention. These fibers also may be made from single and/or multiconstituent or multicomponent fibers.

The films used with the present invention can be made in a wide variety of thicknesses and from a wide variety of polymers. If the laminate formed by the present invention is intended to pass liquids, the film should be provided with apertures or other pores of sufficient size so as to be able to pass liquids including body fluids such as blood, urine or menses. In addition, if desired, it is possible to make the film layer breathable, especially when the laminate is being used as an outer cover on a personal care absorbent article. Breathability can be imparted by, for example, using fillers in the film polymer formulation, extruding the filler/polymer formulation into a film and then stretching the film sufficiently to create voids around the filler particles, thereby making the film breathable. Generally, the more filler used and the higher the degree of stretching, the

greater will be the degree of breathability. If the film is to be bonded to a fibrous nonwoven layer, it may be desirable to make it from or design it such that it is heat bondable to the other layer of the laminate.

As will be explained in greater detail below in conjunction with the process description, the two layers 12 and 14 are bonded to one another along a plurality of bond lines 16 in such a fashion that a plurality of longitudinal and/or transverse pleats or corrugations are formed in the laminate 10. These bond lines may be continuous or discontinuous and will be generally parallel to one another. By "generally parallel" it is meant that the bond lines themselves or an extension of the bond lines will either not intersect or if they do intersect, the interior angle formed by the intersection will be less than or equal to 45 degrees.

Referring again to Figure 1, the areas 18 adjacent the bond lines 16 in the compressible fibrous nonwoven layer (second layer 14) have an increased density as compared to the density of the portions 20 of the compressible web 14 intermediate the bond sites 16. This is because the fibers of the compressible web 14 are more tightly compacted in the areas 18 surrounding the bond lines 16. As a result, the material in these areas has a higher density and smaller pore sizes than the material in the areas 20 intermediate the bond lines 16.

Referring to Figures 2 and 3, the laminate material 10 of the present invention can be used, for example, on a personal care absorbent article 40 as a body side liner 42 with the second layer 14 position adjacent an absorbent core 44 or some other internal component of the article 40. Such articles 40 will also typically include some type of backing or outer cover 46 such as a plastic film or other generally

liquid impervious material.

With the film side of the laminate 10 adjacent the user and the nonwoven side adjacent the absorbent core 44, fluid entering the laminate 10 through the first layer 12 in the raised or convex areas 20 intermediate the bond lines 16 will pass through the first layer 12 and come in contact with the lower density portion of the nonwoven material 14. Due to what the inventors believe to be capillary action, this fluid will be drawn down to the areas 18 adjacent the bond sites 16 where the nonwoven has a higher density and from there the fluid will be drawn/passed into the absorbent core 44. Consequently, a structure can be formed which will have less affinity for body fluids in the raised or convex areas 20 which are adjacent the wearer's skin and a higher affinity for the same fluid in the more densified areas 18 around the bond sites 16 where the fluid can then be transferred to the absorbent core 44.

As can be seen from the cross-section of the material in Figure 1, the laminate 10 has raised peaks separated by valleys with the raised areas or peaks being in vertical registry with the less dense areas 20 and the valleys being in vertical registry with the bond lines 16. As a result, the material is particularly well-suited for use as a liner on a sanitary napkin, incontinence device or other product designed to receive and absorb more viscous and/or particulate containing fluids such as is the case with blood, menses and feces. These materials which do not readily flow through the liner material can collect in the valleys which in turn distances these materials from the user's skin thereby providing improved dryness and comfort.

Referring to Figure 4, one method and apparatus for forming materials according to the present invention involves

stretching one of the two layers 12 and 14 in one direction prior to the bonding of the stretched layer to the non-stretched layer. Once the two layers have been bonded to one another the stretching or tensional forces can be relaxed thereby causing the composite to retract and corrugate or pleat. Thus, for example, the nonwoven second layer 14 can be stretched in the machine direction and then bonded to the film layer 12. Conversely, the film layer 12 can be stretched and then bonded to the unstretched fibrous nonwoven second layer 14. To accomplish this, the first layer 12, which in this case for illustration purposes only is a film, is unwound from a first unwind 30 while the second layer 14, which is a fibrous nonwoven web, is unwound from a second unwind 32. The second layer is unwound in such a fashion that as it comes into the bonding apparatus 34, it is in a stretched or tensioned condition. This can be accomplished, for example, by braking and/or driving the second unwind 32 at a speed which is less than the speed of the first unwind 30/first layer 12 and less than the rotational surface speed of the corrugated bonding roll 35 which is part of the bonding apparatus 34. By stretching one of the two layers in a direction transverse to the bond lines, the laminate will corrugate in between the bond lines 16 when the tension is released. As shown in Figure 4, the corrugated bonding roll 35 imparts bond lines which are transverse to the machine direction of the material. Alternatively, the corrugated bonding roll 35 can have its teeth running parallel to the machine direction of the apparatus in which case the stretching of one of the layers must be in the cross-machine direction.

As shown in Figure 4, the bonding and corrugating apparatus 34 includes a corrugated or geared tooth bonding roll 35 and an ultrasonic horn 38. The ultrasonic horn is activated and as each of the raised tooth portions of the

bonding roll 35 comes in registry with the horn 38 bonding results whereas between the teeth no bonding takes place. As a result, a line of bonding is achieved between the first layer 12 and the second layer 14 with the nonwoven material being more densely compacted at the bond sites 16 and the areas 18 immediately surrounding the bond sites 16 as compared to the convex portions 20 intermediate the areas 18. Once the bonding of the two layers has been completed and the laminate 10 thus formed, the tensional forces are released and the laminate is allowed to relax, thus enhancing the corrugations or pleats in the laminate 10 as it is wound onto a take-up roll 39. Additionally,an adhesive spray applicator 33 may be positioned between the two layers 12 and 14 to spray or otherwise apply a layer of adhesive to one or both the layers 12 and 14 prior to their entering the bonding apparatus 34.

An important feature of the above-described process is the corrugations or pleats caused by stretching one of the first and second layers, bonding the layers together and then retracting the overall laminate. The corrugations or pleats increase the overall surface area per unit area of laminate 10 thereby making the laminate thicker and more bulky.

A second process and apparatus for forming laminates 10 according to the present invention is shown in Figure 5 of the drawings. This process is similar to and run in the same manner as the process shown in Figure 4. As a result, like reference numerals are used for like elements. The main difference is in the bonding apparatus 34.

The bonding apparatus 34 in Figure 4 includes a geared tooth bonding roll 35 and an ultrasonic horn 38. In Figure 5 the ultrasonic horn 38 has been replaced with a second geared tooth bonding roll 36 which is designed to intermesh

with the first geared tooth bonding roll 35. In order to bring about bonding and/or densification, it is desirable that heat be applied to one or both of the webs either just before or during bonding. Consequently, one or both of the bonding rolls 35 and 36 may be heated to thermally bond the two layers of material together. If the bonding rolls are not heated, then a preheating of the webs must take place as with, for example, an infrared or through-air bonding apparatus 37 positioned just before the bonding apparatus 34. Alternatively or in addition to the heating of one or both of the webs, an adhesive spray applicator 33 may be positioned between the two layers 12 and 14 to spray or otherwise apply adhesive to one or both the layers 12 and 14 prior to their entering the bonding and corrugating apparatus 34.

Turning to Figure 6, the first geared tooth bonding roll 35 has a plurality of teeth 50 which are designed to intermesh with the valleys 51 between the teeth 53 on the second geared tooth bonding roll 36. The apices 55 of each of the teeth 50 form and angle A while the valleys 51 between the teeth 53 of the bonding roll 36 form a second angle B. Angle A is designed to be greater than angle B. As a result, there is greater area between the apices 55 of the geared tooth roll 35 and the valleys 51 of the geared tooth roll 36 than there is between the apices 57 of the geared tooth roll 36 and the valleys 54 of the geared tooth roll 35. Thus, when a laminate is formed with the nonwoven layer 14 adjacent the first roll 35 and the film layer 12 adjacent the second roll 36, there will be higher degrees of compaction of the two layers together in the areas adjacent the valleys 54 of the first roll 35 than in the valleys 51 of the second roll 36. This in turn will yield a laminate similar to that described in Figures 1 through 3 of the drawings with the bond lines 16 being formed in the areas of intermeshing of the peaks 57 of roll 36 with the valleys 54 of roll 35. It should be noted

that if the angles A and B equal one another there will be uniform density throughout the laminate but as the differential between the angles A and B increases, the density gradient will increase. The degree of densification can be further varied by adjusting the gap between the two rolls 35 and 36. A smaller gap will increase densification.

Variations to the two processes described above include imparting corrugations or pleats to the laminate by making one of the two layers from a heat retractable or heat shrinkable material. Examples of such materials include oriented films that are not heat set and elastomeric materials made from resins including, for example, polyurethanes, polyesters, polyolefins and polyacetates. In this process, the heat shrinkable layer, whether film, nonwoven or otherwise, is bonded to the other layer using one of the bonding mechanisms described above and, once bonded, the laminate is subjected to a sufficient amount of heat to cause the heat shrinkable layer to retract thereby causing the laminate to corrugate or pleat. Here again, either the first layer or the second layer can be made heat shrinkable. Care should be taken though that the amount of heat needed to effect shrinking does not destroy the bonding between the layers.

Yet another means for imparting corrugations or pleats to the laminate involves stretching one of the layers and bonding it to the other layer with the other layer being made from a heat shrinkable material. Once the two layers are bonded, the tension in the stretched layer can be relaxed and heat can be applied to the laminate thereby providing two means within the same laminate for creating corrugations or pleats.

Having described the materials, apparatus and processes of the present invention, it should become apparent that

various modifications can be made to the present invention. For example, turning to Figures 7 through 10 there are shown several additional body side liner designs which can be made utilizing the present invention. Referring to Figure 7, there is shown a body side liner 90 wherein the bond lines 16, while still linear in nature, are not continuous but instead broken lines of bonding. Such broken lines of bonding will still form corrugations and as a result are still considered to be within the scope of the present invention and the term "bond lines."

In Figure 8 of the drawings there is shown a body side liner 100 which has two side regions 102 and 104 separated by a central region 106. As can be seen from the drawing, the central region 106 contains the corrugations while the side regions 102 and 104 are devoid of any corrugations. Figure 9 is the same as Figure 10 but for the fact that the corrugations in the central region 106 are generally parallel to the longitudinal axis 110 and generally perpendicular to the transverse axis 112 whereas the corrugations in Figure 8 are generally perpendicular to the longitudinal axis 110. By "generally perpendicular" it is meant that the bonds lines or an extension thereof intersect at an interior angle which is greater than 45 degrees and less than or equal to 90 degrees. Lastly, in Figure 10 of the drawings, the body side liner 100 has corrugations in all regions 102, 104 and 106 with the corrugations in the central region 106 being generally perpendicular to the corrugations in the side regions 102 and 104. Of course the direction of the corrugations in region 106 as compared to regions 102 and 104 can be reversed.

Having described the materials and processes of the present invention, several sample materials were prepared and tested to demonstrate the present invention. The test procedures and examples are set forth below.

TEST PROCEDURES

Several test methods were employed in determining the properties of the materials according to the present invention. The methods for determining these properties are set forth below.

INTAKE AND REWET TESTING

The absorption time test indicates the intake rate for a material or laminate using of synthetic menstrual fluid. The composition of the synthetic menstrual fluid comprised, on a weight percent basis, approximately 82.5% water, 15.8% polyvinyl pyrrolidone and 1.7% salts, coloring agents, and surfactants. It has a viscosity of 17 centipoise and a surface tension of 53.5 dynes per centimeter. A 3 inch by 5 inch (7.6 cm by 12.7 cm) sample of the test material was placed on top of nonabsorptive surface and insulted with 10 cc of synthetic menstrual fluid delivered from a fluid reservoir having a 2 inch by 0.5 inch (5.1 cm by 1.3 cm) delivery slot. The block was marked with a level line to indicate when 8 of the 10 cc has been delivered. The time to absorb 8 cc of fluid was then measured in seconds. A lower absorption time as measured in seconds was an indication of a faster intake rate for a particular material. The values reported in the Examples were based upon an average of five samples.

After determining the time to absorb 8 cc of fluid, an additional one minute of time was allowed to elapse to permit the additional 2 cc of fluid in the delivery block to be absorbed into the sample. Next the delivery block was removed and a preweighed piece of blotter paper was placed on top of the sample and a one pound per square inch (0.070 kg/cm^2)

pressure was applied to the blotter paper and specimen for a period of three minutes. At the end of the three minute period the blotter paper was removed and weighed and the amount of synthetic menstrual fluid absorbed by the blotter paper was measured in grams and was an indication of the degree of rewet. Higher values were an indication of a greater degree of rewet for the particular material tested. The values reported in the Examples were based upon an average of five samples.

THICKNESS

The thickness of the materials, including laminates, was measured using the Starrett Bulk test. Under this test a 12.7 x 12.7 centimeter sample of the material was compressed under a load of 0.05 pounds per square inch (3.5 grams per square centimeter) and the thickness was measured while under this load. Higher numbers indicate a thicker material. Five samples were measured for each material and then averaged. Values given are for the average.

BASIS WEIGHT

The basis weights of the various materials described herein were determined in accordance with Federal Test Method Number 191A/5041. Sample size for the specimens was 15.24 x 15.24 centimeters and three values were obtained for each material and then averaged. The values reported below are for the average.

Pore Size and Density Gradient Tests

The method for determining the Pore Size Gradient and Density Gradient is described below. The method involves taking several representative cross sections of a laminate sample and

photographing the fiber network of the cross section by image analysis. The Pore Size is determined by measuring the distance between the fibers as the image is scanned from bond line to bond line and is reported in millimeters. The Density Gradient is calculated by measuring the vertical height of several scan lines from bond line to bond line and dividing the basis weight by the measured height.

Sample Preparation

A cut section of sample was placed face up in an embedding mold. Enough embedding medium was added to completely saturate and surround the sample. After curing, additional medium was added and cured where samples had floated, resulting in part of the sample not being fully embedded.

Cured molds were trimmed with a belt sander to expose the sample and produce faces parallel to the Y-Z plane of the sample thereby providing a cross-sectional view of the sample. Thin sections were then cut with a microtome for mounting on glass microscope slides.

Two to three photomicrographs from each of two to three cross sections per sample were obtained to produce 6 photomicrographs per sample. Photographic exposure was adjusted to produce bright fibers on a black background.

Sample size:	0.75" (19.1mm) x 1.5" (38.2mm) MD parallel to short dimension
Embedding mold:	1" (25.4mm) x 1.75" (44.5mm) x 0.75" (19.1mm) deep
Embedding medium:	LADD ultra low viscosity epoxy (use recommended formulation for a medium

hardness block)

Microtome:	Reichert Polycut E with tungsten carbide type D knife
Section thickness:	25 um
Microscope slides:	2" (50.8mm) x 3" (76.2mm) glass
Cover slips:	24mm x 50mm glass
Mounting medium:	Resolve brand microscope immersion oil n_D = 1.5150
Microscope:	Leica Wild M-420 Makroskop
Camera:	Leica with polaroid sheet film back
Film:	Polaroid T-53 (ASA 800) 4" (101.6mm) x 5" (127.0mm) instant sheet film
Magnification:	10.3X
Exposure conditions:	transmitted illumination, dark field

Measurement Technique

Image analysis by QUANTIMET 970 (Cambridge Instruments, Deerfield, Illinois) macroviewer using a 35 mm lens, autostage as a spacer, 65-cm camera pole position, and 4 incident flood lamps. A series of ten fields were scanned for each example. Computer Program #1 was used to scan for Pore Size Gradient and Computer Program #2 was used to scan for Density Gradient. The results are shown in Tables 1 and 2.

COMPUTER PROGRAM #1

```
Cambridge Instruments QUANTIMET 970 QUIPS/MX:  V08.00

DOES = SPACING VS DEPTH POSN OF NW MATERIAL
COND = 35 MM LENS; 65 CM POLE POSN; 4 FLOODS; ASTGE SPACER

Enter specimen identity
Scanner      ( No. 1 Chalnicon LV= 0.00 SENS= 1.94 PAUSE )
Load Shading Corrector ( pattern - CHRIS1)
Calibrate User Specified (Cal Value = 0.01077 millimeters per
pixel for photos at 10.3X magnification)
SUBRTN STANDARD

TOTFIELDS          := 0.
TOTAREA            := 0.
X                  := 0.
Y                  := 0.
W                  := 0.
H                  := 0.
TEMP               := 0.
NUMFIELDS          := 1.
Input NUMFIELDS

For FIELD
Detect 2D          ( Lighter than 64, Delin )
Image Frame (Pause) is Rectangle ( X: 228, Y: 84, W: 448,
H:451, )
X           := I.FRAME.X - 2.
Y           := I.FRAME.Y - 2.
W           := I.FRAM.WR + 6.
H           := I.FRAME.H + 4.
Live Frame is Rectangle ( X:X    , Y:Y     , W:W     ,  H:H
, )
```

```
Detect 2D          ( Lighter than 24, Delin PAUSE )
Amend          ( OPEN by 1 )
Edit (pause)

Measure feature  AREA           X.FCP          Y. FCP
  into array FEATURE (of 400 features and 10 parameters )
Accept FEATURE AREA from             0. to      0.03000
Nearest neighbour in FEATURE    (CALC.A,CALC.B,CALC.C)
ORIGIN := L.FRAME.X
FEATURE     X.MIN      := X.FCP - ORIGIN
FEATURE     X.MIN      := X.MIN * CAL.CONST
FEATURE     CALC.C     := CALC.C * CAL.CONST
FEATURE     CALC.C     := CALC.C / NUMFIELDS
Distribution of CALC.C (Units MM      ) v X.MIN (Units MM )
  from FEATURE in HISTO1 from   0. to 4.000
  in 20 bins (LIN)

TOTFIELDS   :=  TOTFIELDS + 1.

Pause Message
PLEASE CHOOSE ANOTHER FIELD, OR "FINISH"
Pause

Next FIELD

Print " "
Print "   TOTAL NUMBER OF FIELDS SCANNED = " , TOTFIELDS
Print " "
Print Distribution ( HISTO1, differential, bar chart, scale
= 0.00)
Print " "
Print " "
Print " "

For LOOPCOUNT  =  1 to          10
```

```
Print "."
Next

END OF PROGRAM
```

COMPUTER PROGRAM #2

```
Cambridge Instruments QUANTIMET 970 QUIPS/MX:  V08.00

Enter specimen identity
Scanner      ( No. 1 Chalnicon LV= 0.00 SENS= 1.94 PAUSE )
Load Shading Corrector ( pattern - CHRIS1)
Calibrate User Specified (Cal Value = 0.01077 millimeters per
pixel for photos at 10.3X magnification)
SUBRTN STANDARD

TOTFIELDS         := 0.
TOTAREA           := 0.
FRAMEPOSX         := 0.
XPOS              := 0.
FLDAREA           := 0.
INCRMNT           := 30.
STARTPOS          := 125.
X                 := 0.
Y                 := 0.
W                 := 0.
H                 := 0.

For FIELD
Detect 2D         ( Lighter than 64, Delin )
Image Frame (Pause) is Rectangle ( X: 204, Y: 118, W: 489, H:
398, ) Choose a field much larger than "corrugation," to give
room for 40 dilations.
```

```
X              := I.FRAME.X
Y              := I.FRAME.Y
W              := I.FRAM.WR
H              := I.FRAME.H
Detect 2D          ( Lighter than 24, Delin PAUSE )
Edit (pause) EDIT get rid of neighboring "corrugation" pieces,
and restore valley floor by DRAW of a LINE.
Amend          ( CLOSE by 40 )
Image Frame (Pause) is Rectangle  ( X: 243, Y: 133, W: 415,
H: 313, ) Place this frame accurately to bisect valley floors
on either side of "corrugation."
Live Frame is Rectangle ( X:X    , Y:Y     , W:W     ,  H:H
, )
YPOS                := I.FRAME.Y
INCRMNT             := I.FRAM.WR / 20.
HEIGHT              := I.FRAME.H
STARTPOS            := I.FRAME.X
Edit (pause) EDIT Use EDIT/LINE to take slices (vertical) from
filled "corrugation".
Measure feature  AREA    FERET 90    X.FCP           Y. FCP
  into array FEATURE ( of 200 features and 5 parameters )
FEATURE     CALC       := ( ( X.FCP = I.FRAME.X ) * CAL.CONST
)
Distribution of FERET (Units MM ) v CALC (Units MM  )
  from FEATURE in HIST01 from   0. to 5.000
  in 25 bins (LIN)
Distribution of COUNT v CALC (Units MM    )  need  this  to
divide  HIST01  class  data  by  COUNT/CLASS  in  HIST02,  for
obtaining per-class averages.
  from FEATURE in HIST02 from   0. to 5.000
  in 25 bins (LIN)

TOTFIELDS   :=  TOTFIELDS + 1.

Pause Message
```

```
PLEASE CHOOSE ANOTHER FIELD, OR "FINISH"
Pause

Next FIELD

Print " "
Print "   TOTAL NUMBER OF FIELDS SCANNED = " , TOTFIELDS
Print "    TOTAL AREA SCANNED (sq cm) = ", CL.FRAREA *
TOTFIELDS / 100.
Print " "
Print "EACH FRAMEPOSX = " , L.FRAM.WR * CAL.CONST , "(mm)"
Print " "
Print " "
Print Distribution ( HISTO1, differential, bar chart, scale
= 0.00)
Print " "
Print " "
Print " "

For LOOPCOUNT  =  1 to        20
Print " "
Next
Print " "
Print " "
Print Distribution ( HISTO2, differential, bar chart, scale
= 0.00)
For LOOPCOUNT   =  1 to       20
Print " "
Next


END OF PROGRAM
```

EXAMPLES

EXAMPLE 1

In Example 1 a film/nonwoven laminate was made in accordance with the above-described process shown in Figure 4. The base film was a 1 mil (0.00254 centimeter) thick low density polyethylene film containing 4 percent by weight titanium dioxide (TiO_2) uniformly dispersed throughout the film. The film polymer was NA-206 low density polyethylene (LDPE) from Quantum, Inc. of Wallingford, Connecticut. The TiO_2 was in concentrate form and was obtained from the Ampacet Company of Mount Vernon, New York and designated 110313. The film once formed was mechanically apertured with approximately 25 percent open area. The individual apertures were approximately 550 microns in diameter (equivalent circular diameter). After aperturing the film thickness was approximately 0.015 inches (0.0381 cm).

The compressible fibrous nonwoven web portion of the laminate was a bicomponent spunbond web having a basis weight of 34 grams per square meter (gsm). The fibers were of a side-by-side construction with a fiber denier of 5 and a fiber diameter of 28.2 microns. The fibers included 50 percent by weight Exxon 3445 polypropylene from the Exxon Chemical Company of Darien, Connecticut and 50 percent by weight Dow grade 6811A polyethylene from the Dow Chemical Company of Midland, Michigan. The web was through air bonded at a temperature of 267°F (128°C) with a dwell time of less than one second. The web was treated, on a dry weight basis, with 0.4 percent Y12488 polyalkylene oxide-modified polydimethylsiloxane non-ionic surfactant wetting package based upon the total weight of the web. The surfactant was manufactured by OSi Specialties, Inc. of Danbury, Connecticut. The web had a thickness of 0.1524 cm. Such bicomponent webs

can be made in accordance with the teachings of U.S. Patent No. 5,336,552 to Strack et al. which is incorporated herein by reference in its entirety.

The film was fed into the bonding apparatus such that it was adjacent the geared tooth bonding roll and was traveling at approximately the same speed as the geared tooth bonding roll which had a rotational surface speed of 5 meters per minute (m/min). The geared tooth bonding roll was not heated but was at ambient temperature which was approximately 20°C. The geared tooth bonding roll had a diameter of 6.173 inches (15.7 cm) as measured from tooth apex to tooth apex. The teeth had flat tops and vertical sides. The tooth width was 0.025 inches (0.635 mm). Vertical depth of the teeth was 0.254 centimeters and the tooth-to-tooth spacing was 0.18 inches (4.57 mm) (center line to center line). The ultrasonic horn assembly used in the bonding apparatus was manufactured by the Branson Ultrasonics Corporation of Danbury, Connecticut. The horn itself was a nine inch (23 cm) horn with a gold booster having a 1 to 1.5 gain ratio. The booster was connected to a model 900 actuator which was in turn connected to a model 900B 300 watt/20,000 Hz power supply. For Example 1 the horn was adjusted to 50 percent output. The nonwoven web was positioned adjacent the ultrasonic horn and was fed into the bonding apparatus at a speed which was approximately two thirds that of the bonding roll. As a result, the nonwoven web was stretched approximately 50 percent before it was bonded to the film layer. After the bonding step the laminate was withdrawn and allowed to relax thereby causing the laminate to corrugate.

A cross-sectional side view of the laminate is shown in Figure 11 of the Drawings. As can be seen from the photo of Figure 11, the laminate has reduced skin contact area on the film side due to the corrugation of the two materials. The

overall height or thickness of the corrugations at their highest point averaged approximately 1.1 millimeters. Spacing between adjacent apices was approximately 4.5 millimeters and the spacing between adjacent bond lines was approximately 4.5 millimeters. This corrugated effect is perceived as being advantageous as it should allow for more air circulation and less contact with the skin which is important especially when the material is wet as with, for example, urine or menses. On the nonwoven side of the laminate, the spacing between the fibers is much more open with more interfiber spacing in the area adjacent the apices of the corrugations. Conversely, the fiber spacing in the areas of the fibrous nonwoven web to either side of the bond lines is much closer thus creating a higher density fiber structure as compared to the above-described areas intermediate the bond lines. Consequently,the nonwoven side can be seen as having two density zones, a low density zone at the apex of the corrugations approximately intermediate two adjacent bond lines and a higher density zone on either side of the bond lines. As a result, a density differential is formed between the top of the corrugations and the bottoms which also creates a pore size gradient which fosters fluid flow away from the tops of the corrugations which are most likely to be in closest proximity to the wearer's skin and toward the bond lines which are typically closer the additional absorbent material such as the absorbent core of a personal care absorbent article.

Density measurements were taken of the laminate in accordance with the test procedures outlined above. Midway between the bond lines at the approximate apices of the corrugations the density of the nonwoven web portion of the laminate (it being assumed that there was little or no change in the density of the film layer) was 0.023 grams per cubic centimeter (g/cc) while in the areas just adjacent the bond lines the density of the nonwoven was approximately 0.173 to

0.236 g/cc based upon a ten sample average of the material of Example 1. See Table 1. As is also shown in Table 1, there is a gradual increase in density values from the apex in either direction to the areas adjacent the bond lines.

TABLE 1

	EXAMPLE 1 Density g/cc	EXAMPLE 2 Density g/cc
Area adjacent bond line	0.291	0.200
	0.173	0.090
	0.070	0.047
	0.047	0.032
	0.035	0.027
	0.030	0.022
	0.029	0.019
	0.027	0.019
	0.026	0.017
	0.025	0.018
	0.025	0.018
Apex	0.024	0.017
	0.026	0.019
	0.025	0.022
	0.028	0.026
	0.029	0.031
	0.032	0.038
	0.044	0.048
	0.057	0.096
	0.108	0.125
	0.236	0.150
Area adjacent bond line	0.358	0.351

Pore size measurement were also taken of the laminate in accordance with the test procedures outlined above. Midway between the bond lines at the approximate apices of the corrugations the pore size of the nonwoven web portion of the laminate was approximately 0.65 mm in size while in the areas just adjacent the bond lines the density was approximately 0.21 to 0.29 mm based upon a ten sample average of the material in Example 1. See Table 2.

TABLE 2

	EXAMPLE 1	EXAMPLE 2
	Pore Size mm	Pore Size mm
Area adjacent bond line	0.29	0.26
	0.57	0.49
	0.41	0.62
	0.52	0.94
	0.63	0.78
	0.62	0.91
	0.61	0.85
	0.69	0.87
	0.62	0.82
Apex	0.65	0.98
	0.67	0.78
	0.59	0.99
	0.76	0.94
	0.59	0.90
	0.49	0.66
	0.62	0.56
	0.41	0.56
Area adjacent bond line	0.21	0.31

The film nonwoven laminate of this example was tested for fluid handling performance using the intake time and rewet tests described above. Swatches of the laminate were cut and placed on top of a two layer absorbent core with the nonwoven side adjacent the absorbent to simulate the cover material of a personal care absorbent article, in this case a feminine pad or sanitary napkin. On the back side of the pad there was placed a layer of thermoplastic film. The top body side layer of the core was a 425 gsm fluff with a density of approximately 0.07 g/cc and the baffle side layer was a 470 gsm fluff with a density of approximately 0.094 g/cc. The baffle side layer was embossed with an acorn pattern.

The fluid handling performance of the laminate material was compared to the identical components in a layered or nonlaminated state. Thus the nonwoven and apertured film were separately cut and layered on top of the two layer absorbent core with the nonwoven material placed adjacent the absorbent core.

The laminate and layered cover material samples were tested for fluid intake time and rewet using the synthetic menstrual fluid described above. The results of the testing are given in Table 3 below:

TABLE 3

	Intake time (sec)	Rewet (g)	Thickness (mm)
Corrugated film/NW	11.47	0.25	1.63
Layered film/NW	12.38	0.56	1.19

As is readily apparent from the data presented above, the corrugated laminate material according to the present invention had an improved intake time and significantly reduced rewet compared to the identical layered structure. Thus, the fluid was absorbed into the feminine pad faster with less fluid rewet to the surface. This decreased rewet is believed to be due in part to the increased separation between the user and fluid absorbed in the absorbent core caused by the corrugations as can be seen from the significantly increased thickness of the corrugated laminate. The decreased rewet is also believed to be due to the density gradient that is created within each corrugation that transports and retains the fluid away from the user, thus allowing less fluid to rewet the surface.

EXAMPLE 2

In Example 2 a nonwoven/nonwoven laminate was made in the same manner and under the same conditions as the material in Example 1. The only difference was that the film layer was replaced with a 14 gram per square meter spunbond polypropylene web containing 4 percent by weight TiO_2, based upon the total weight of the fiber/web. The polypropylene resin was designated E5D47 and was obtained from the Shell Chemical Company. The TiO_2 was obtained from the same supplier as in Example 1 and bore the designation 41438. The fibers from which the web were formed had a denier of 5 and a diameter of 28.2 microns. The web was thermally point bonded with an approximate bond area of 15 percent. The bond pattern consisted of a staggered row of diamond shaped bond points having equal length sides with a bond area of approximately 0.009 square inches (0.058 cm^2). The web was treated on a dry weight basis, based upon the total weight of the web, with 0.5 percent Triton X-102 nonionic surfactant from the Union Carbide Company of Sisterville, Virginia.

The other nonwoven web was the same bicomponent spunbond web used in Example 1. The two webs were fed into the apparatus in the same manner in Example 1 with the 14 gsm polypropylene spunbond web adjacent the geared tooth bonding roll and the ultrasonic horn set at 60 percent power. The resultant laminate in shown in cross-section in the photograph of Figure 8 of the drawings. The overall height of the corrugations at their highest point averaged approximately 2 millimeters. Spacing between adjacent apices was approximately 4 millimeters and the spacing between adjacent bond lines was approximately 4 millimeters. Once again, this corrugated effect is perceived as being advantageous as it should allow for more air circulation and less contact with the skin. As with the laminate in Example 1 the spacing between the fibers was much more open with more interfiber spacing in the areas adjacent the apices of the corrugations. Conversely, the fiber spacing in the areas of the fibrous nonwoven web to either side of the bond lines was much closer thus creating a higher density fiber structure as compared to the above-described areas intermediate the bond lines. Consequently,the laminate can be seen as having two density zones, a low density zone at the apex of the corrugations approximately intermediate two adjacent bond sites and a higher density zone on either side of the bond lines. As a result, a density differential is formed between the top of the corrugations and the bottoms which also creates a pore size gradient which fosters fluid flow away from the tops of the corrugations which are most likely to be in closest proximity to the wearer's skin and toward the bond lines which are typically closer the additional absorbent material such as the absorbent core of a personal care absorbent article.

Density measurements were taken of the laminates in accordance with the test procedures outlined above and are

reported in Table 1. Midway between the bond lines at the approximate apices of the corrugations the density of the laminate was 0.017 grams per cubic centimeter (g/cc) while in the areas just adjacent the bond lines the density of the laminate was approximately 0.15 to 0.20 g/cc based upon a ten sample average of the material of Example 2.

Pore size measurement were also taken of the laminate in accordance with the test procedures outlined above. Midway between the bond lines at the approximate apices of the corrugations the pore size of the laminate was approximately 0.98 mm in size while in the areas just adjacent the bond lines the pore size was approximately 0.26 to 0.31 mm based upon a ten sample average of the material in Example 2. See Table 2 above.

The nonwoven/nonwoven laminate of this example was tested for fluid handling performance using the intake time and rewet tests described above. The laminate materials were prepared and tested similarly to the procedure described in Example 1. As in Example 1 the bicomponent spunbond web was placed adjacent the absorbent core. The fluid handling performance of the laminate material was compared relatively to the identical material components in a layered or nonlaminated state. Thus each nonwoven material was separately cut and layered on top of the two layer absorbent core with the bicomponent spunbond material placed adjacent the absorbent core. The results of the testing are given in the Table 4 below:

TABLE 4

	Intake time (sec)	Rewet (g)	Thickness (mm)
Corrugated NW/NW	9.05	0.42	1.24
Layered NW/NW	15.90	0.87	1.19

As in Example 1, the corrugated laminate material had a improved intake time and significantly reduced rewet value, again demonstrating the positive effect of the corrugations on fast fluid intake and reduced rewet. Unlike Example 1, the significant rewet reduction was achieved without a corresponding significant increase in thickness. This is believed to demonstrate the importance of the density gradient imparted in the bicomponent nonwoven web that transports fluid

away from the user and towards the absorbent core which enhances the separation between the body side surface and absorbent and minimizes fluid rewet.

As can be seen from the examples described above, the corrugated laminates have improved fluid intake and rewet performance compared to identical noncorrugated materials. This is believed to correlate with the desirable in-use benefits of faster menses absorption and a drier feeling surface. The corrugations are important to these in-use benefits as they increase the separation between the user and the fluid in the absorbent core and minimize the amount of material in contact with the user. In addition, the density differential and resulting pore size differential between the top and bottom of the corrugations provide the user with a sanitary napkin that readily absorbs menses and maintains a clean and dry feeling body side surface.

Having thus described the invention in detail, it should be apparent that various modifications and changes can be made in the present invention without departing from the spirit and scope of the following claims.

CLAIMS:

1. A laminate comprising a first sheet attached to a second sheet at one or more locations between said first and second sheets to form a laminate,

said laminate having a plurality of generally parallel corrugations forming a series of peaks separated by a series of valleys wherein said laminate in the vicinity of said peaks has a first density and said laminate in the vicinity of said valleys has a second density, said second density being greater than said first density.

2. The laminate of Claim 1 wherein said first sheet is a liquid pervious film and said second sheet is a compressible web.

3. The laminate of Claim 2 wherein said compressible web is a fibrous nonwoven web.

4. The laminate of Claim 2 wherein said fibrous nonwoven web in the vicinity of said peaks has a first average pore size and in the vicinity of said valleys has a second average pore size, said first average pore size being greater than said second average pore size.

5. The laminate of Claim 1 wherein said laminate has a spacing between adjacent peaks of from about 2 and about 7 millimeters.

6. The laminate of Claim 1 wherein said laminate has a vertical height of from about 0.5 to about 5 millimeters.

7. A personal care absorbent article comprising a body side liner and a outer cover with an absorbent core disposed therebetween, said body side liner comprising the laminate of

Claim 1.

8. The personal care absorbent article of Claim 7 wherein said article has a longitudinal axis and a transverse axis, said corrugations being generally parallel to said longitudinal axis of said article.

9. The personal care absorbent article of Claim 7 wherein said article has a longitudinal axis and a transverse axis, said corrugations being generally parallel to said transverse axis of said article.

10. The personal care absorbent product of Claim 7 wherein said body side liner has two side regions separated by a central region all of which contain corrugations, said corrugations of said central region being generally perpendicular to said corrugations of said two side regions.

11. A process for forming a corrugated laminate comprising:

providing a first and second layer of material in generally face to face relationship,

stretching at least one of said first and second layers,

bonding said first layer and said second layer together at spaced apart generally parallel bond lines to form said laminate,

allowing said laminate to relax to form a plurality of corrugations including an alternating series of peaks and valleys with said laminate in the vicinity of said peaks having a first density and said laminate in the vicinity of said valleys having a second density, said second density being greater than said first density.

12. The process of claim 11 which further includes applying an adhesive between said first and second layers prior to said bonding step.

13. A process for forming a corrugated laminate comprising:
providing a first and second layer of material in generally face to face relationship,
bonding said first layer and said second layer together at spaced apart generally parallel bond lines to form said laminate having a plurality of corrugations including an alternating series of peaks and valleys with said laminate in the vicinity of said peaks having a first density and said laminate in the vicinity of said valleys having a second density, said second density being greater than said first density.

14. The process of claim 13 which further includes applying an adhesive between said first and second layers prior to said bonding step.

15. An apparatus for forming a corrugated material comprising:
a first geared tooth roll having a plurality of teeth about its periphery, said teeth on said first roll defining a first angle between said teeth,
a second geared tooth roll having a plurality of teeth about its periphery, said teeth on said second roll defining a second angle between said teeth, said teeth on said first and second rolls intermeshing with one another and forming a gap therebetween, said first angle of said teeth on said first roll being greater than said second angle of said teeth on said second roll.

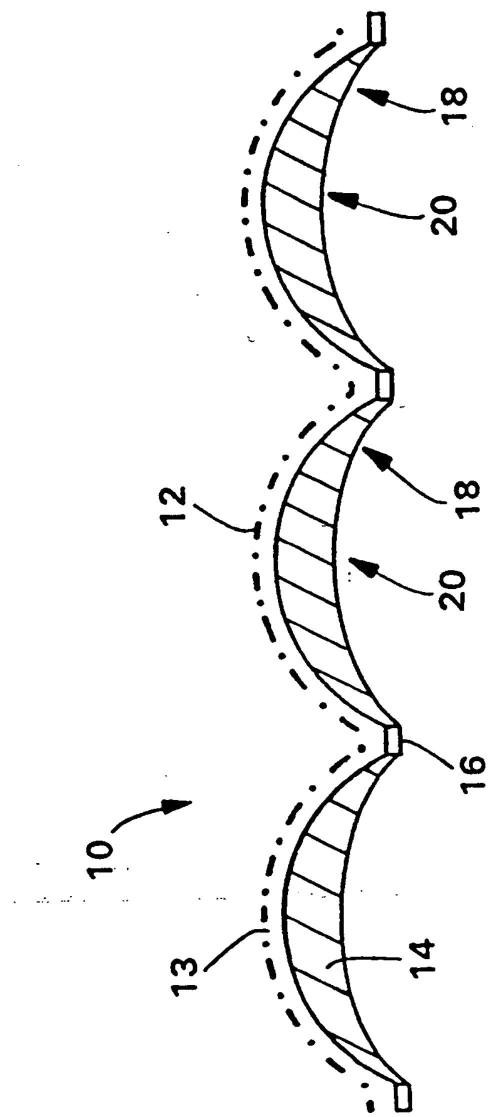

FIG. 1

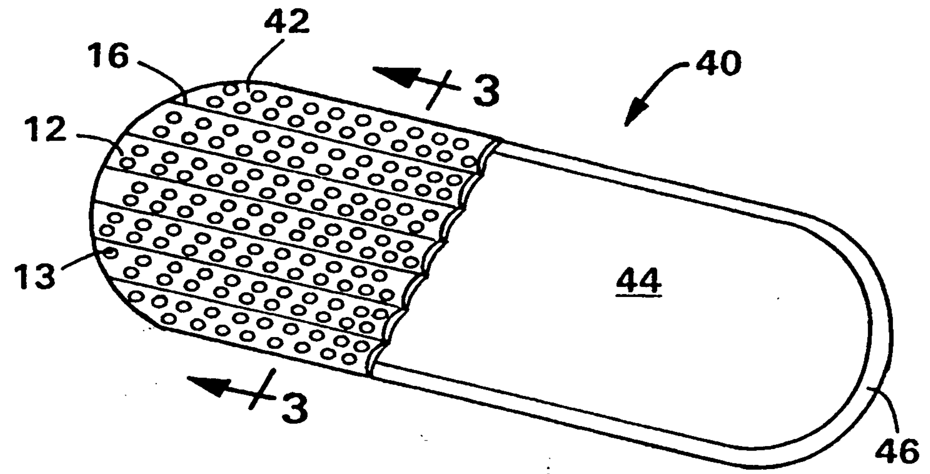

FIG. 2

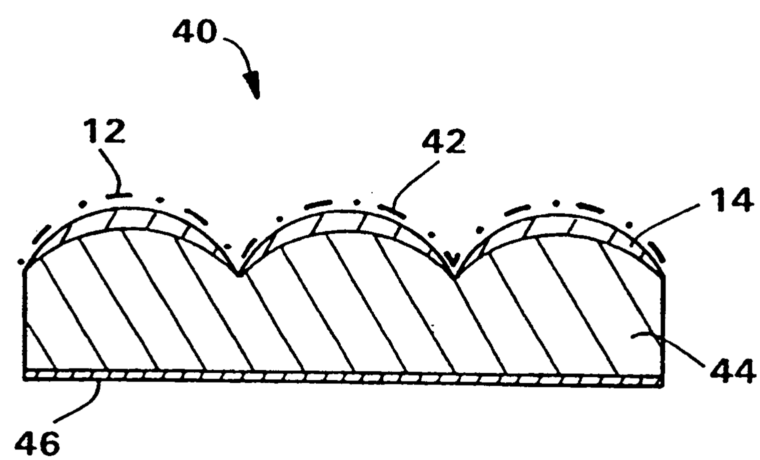

FIG. 3

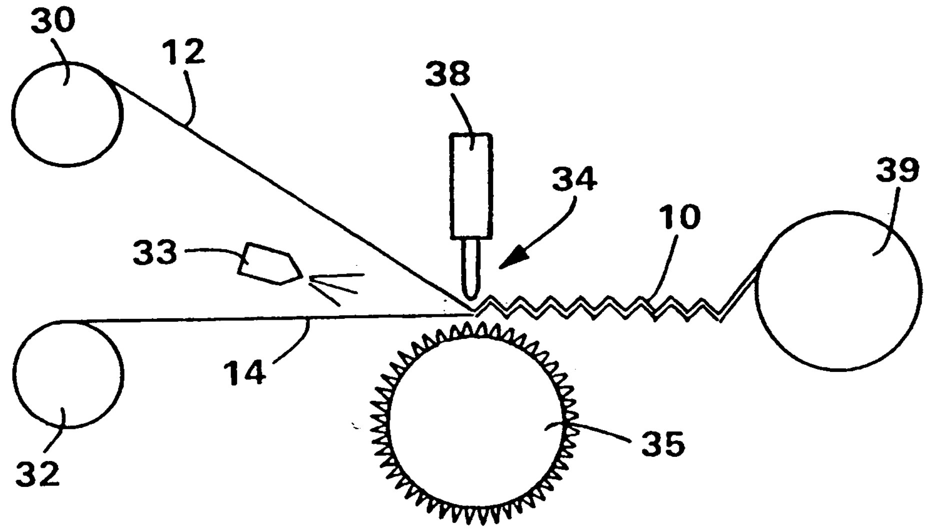

FIG. 4

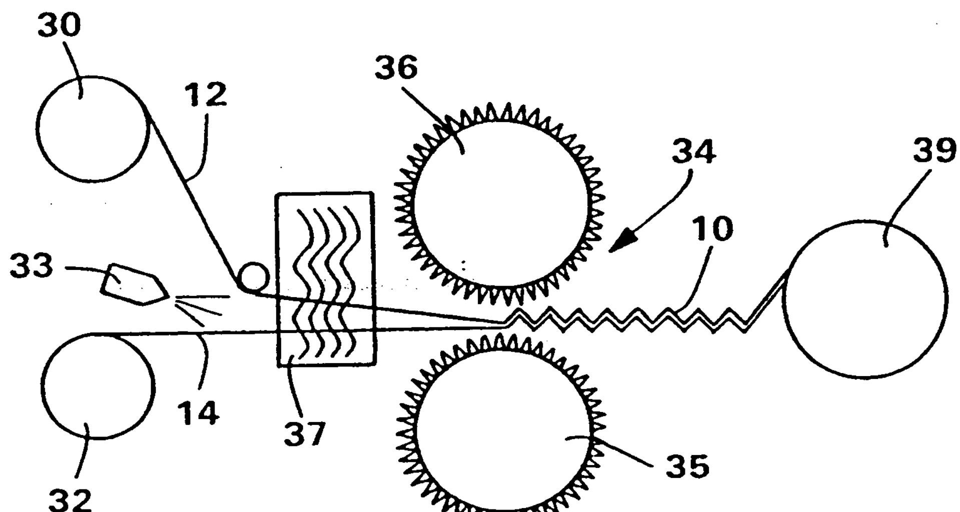

FIG. 5

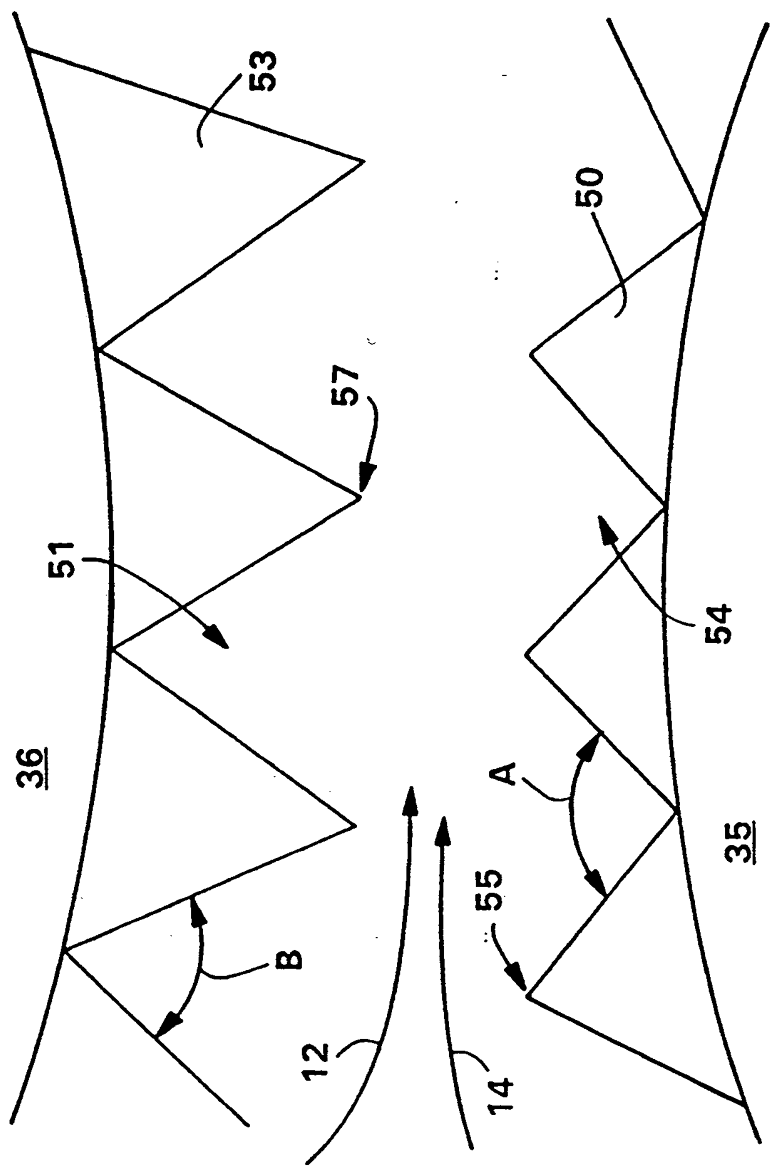

FIG. 6

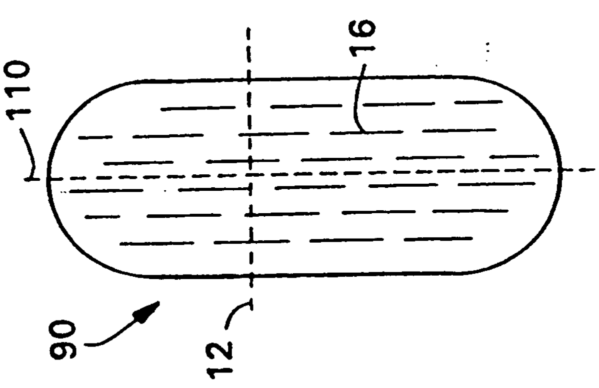

FIG. 7

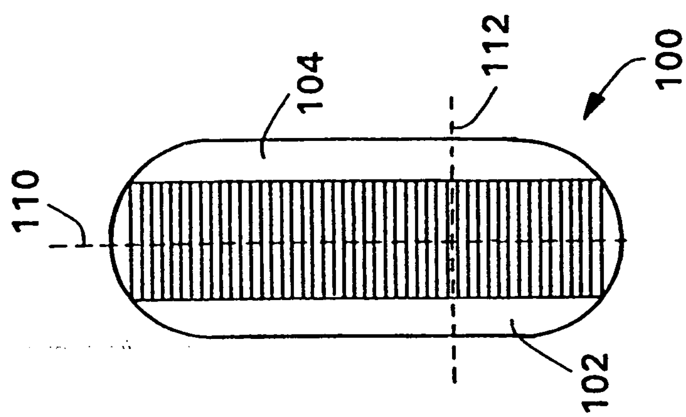

FIG. 8

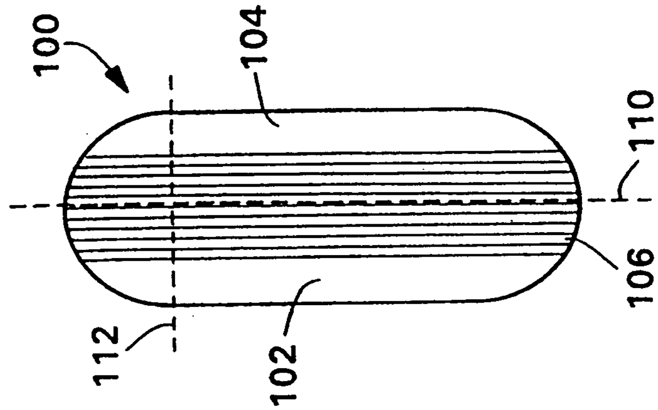

FIG. 9

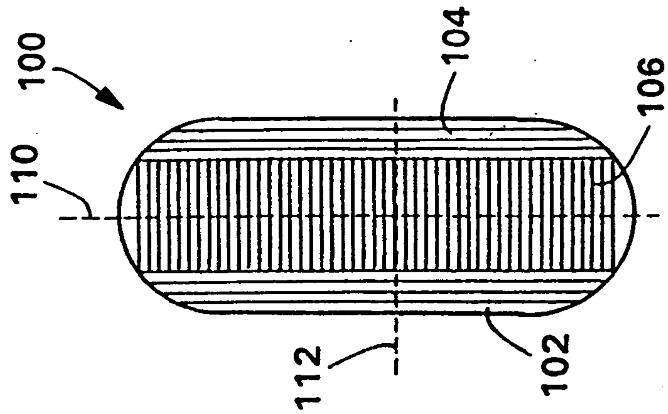

FIG. 10

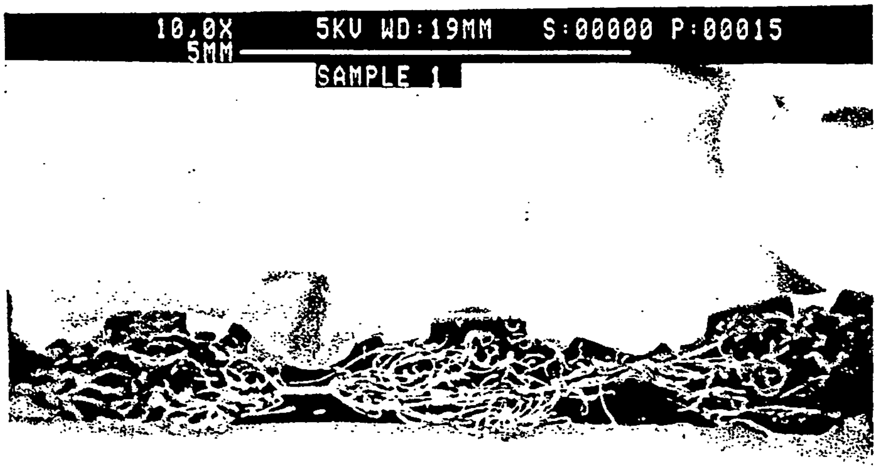
10,0X 5KV WD:19MM S:00000 P:00015
5MM
SAMPLE 1

FIG. 11

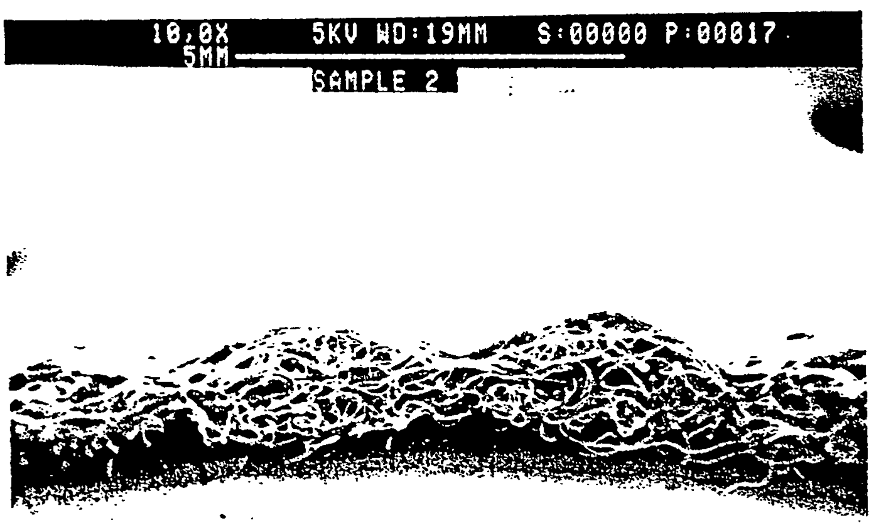
10,0X 5KV WD:19MM S:00000 P:00017
5MM
SAMPLE 2

FIG. 12

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No
PCT/US 97/12535

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 3469286 A	30-09-69	GB 1146293 A NL 6604264 A	 03-10-66
US 3706311 A	19-12-72	CA 957453 A GB 1331680 A	12-11-74 26-09-73
US 4212301 A	15-07-80	NONE	
US 3683915 A	15-08-72	NONE	
US 3643661 A	22-02-72	CA 943703 A	19-03-74
US 3971378 A	27-07-76	NONE	
US 3731687 A	08-05-73	NONE	